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THE TRANSMISSION OF NEUTRONS AND GAMMA-RAYS THROUGH AIR SLOTS. PART VII. THE EFFECT ON THE NEUTRON TRANSMISSION OF CHANGING THE WALL MATERIAL OF AN AIR SLOT

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September 1, 1954

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THE TRANSMISSION OF NEUTRONS AND GAMMA-RAYS THROUGH AIR SLOTS

Part VII

The Effect on the Neutron Transmission of Changing the Wall Material of an Air Slot

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1 September 1954

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REACTOR DEPARTMENT

BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.

under contract with the
United States Atomic Energy Commission

Part VII

The Effect of Changing the Wall Material of an Air Slot on the Neutron Transmission of the Slot

The task of relating experimental information of the type presented in this series of reports to the particular reactor shield with which the designer is concerned is often more nearly an art than a science. In the investigation of the neutron transmission through air slots, we have made a serious attempt to investigate the effect of varying enough of the parameters to make the job of the shield designer as simple as possible. One of those parameters which has been investigated is the material constituting the wall of the slot. This report contains the data which we have obtained relating to the variation of this parameter.

To obtain a reasonable amount of information with a small number of measurements, we have used a single slot thickness to investigate the effect of changing the wall material. When the air slot thickness is large, it is reasonable to expect the effect of the walls to be less important than when the slot thickness is small. However, if the slot thickness is made too small, the construction of the slot will not be sufficiently reproducible to measure accurately the change in the transmission resulting from an alteration in the wall material. The slot thickness which was chosen as being reasonably small and yet readily reproducible was 0.50 inch. .

Since steel is the material which usually forms the walls of a practical air slot, the water equivalent walls of a 0.50 x 34 x 48 inch straight air slot were replaced with 0.50 inch steel sheet. Thermal neutron data above the slot with both lucite and steel walls are presented in Figs. 1 and 2. It is evident from the vertical traverses shown in Fig. 2 that the 30 per cent reduction in thermal flux on introducing the steel walls noted immediately above the slot does not persist as the detector is raised. The fast neutron flux is not, therefore, materially affected by the change. The difference between the two curves in the vicinity of Z = 80 inches is believed to be the result of a difference in the photoneutron background.

Since the effect of changing the wall material is expected to be more important for an offset slot where the direct transmission has been greatly reduced, a comparison has been made between a 0.50 x 34 x 48 inch slot with a 1.80 inch offset located in the middle with lucite and with 0.50 inch steel walls. The thermal neutron traverses above the slot are presented in Figs. 3 and 4. The vertical traverses in Fig. 4 indicate a reduction of about a factor of three close to the slot with the effect of the steel walls becoming much less when the detector was moved several inches away from the slot. The photoneutron backgrounds are not known with sufficient accuracy for these special situations to permit an accurate subtraction of the effect.

The next step in the investigation was to introduce a 1.8 x 34 x 3 inch steel bar at the offset of the lucite-walled slot, mentioned above, since it was felt that the material near the offset would probably be

more effective than material located at other positions in the slot. The location of the steel bar is indicated in the sketch in Fig. 5. That figure also shows vertical traverses obtained with a thermal neutron detector above the slot for three conditions of the slot: (1) no steel in the walls; (2) the 1.8 x 34 x 3 inch steel bar located at the offset; and, (3) the steel bar at the offset and a cadmium sheet in the middle of the upper section. It may be noted that the steel bar has about the same effect on the transmission as the one-half inch steel walls over the entire slot. With the steel bar in place, the reduction in the fast flux was about 25 per cent. The introduction of the cadmium further reduced the low energy component without affecting the fast neutrons.

On the basis of these measurements, we have concluded that the fast neutron transmission of an air slot is essentially independent of the wall material. The low energy component, however, can be affected, presumably by the introduction of material with a large absorption cross section. In practice, of course, consideration must be given to the introduction of large amounts of any material which is appreciably less effective than water as a neutron shield.

At this point, the investigation was terminated since it appeared that the effects were important only for thermal neutrons.

Figure 1

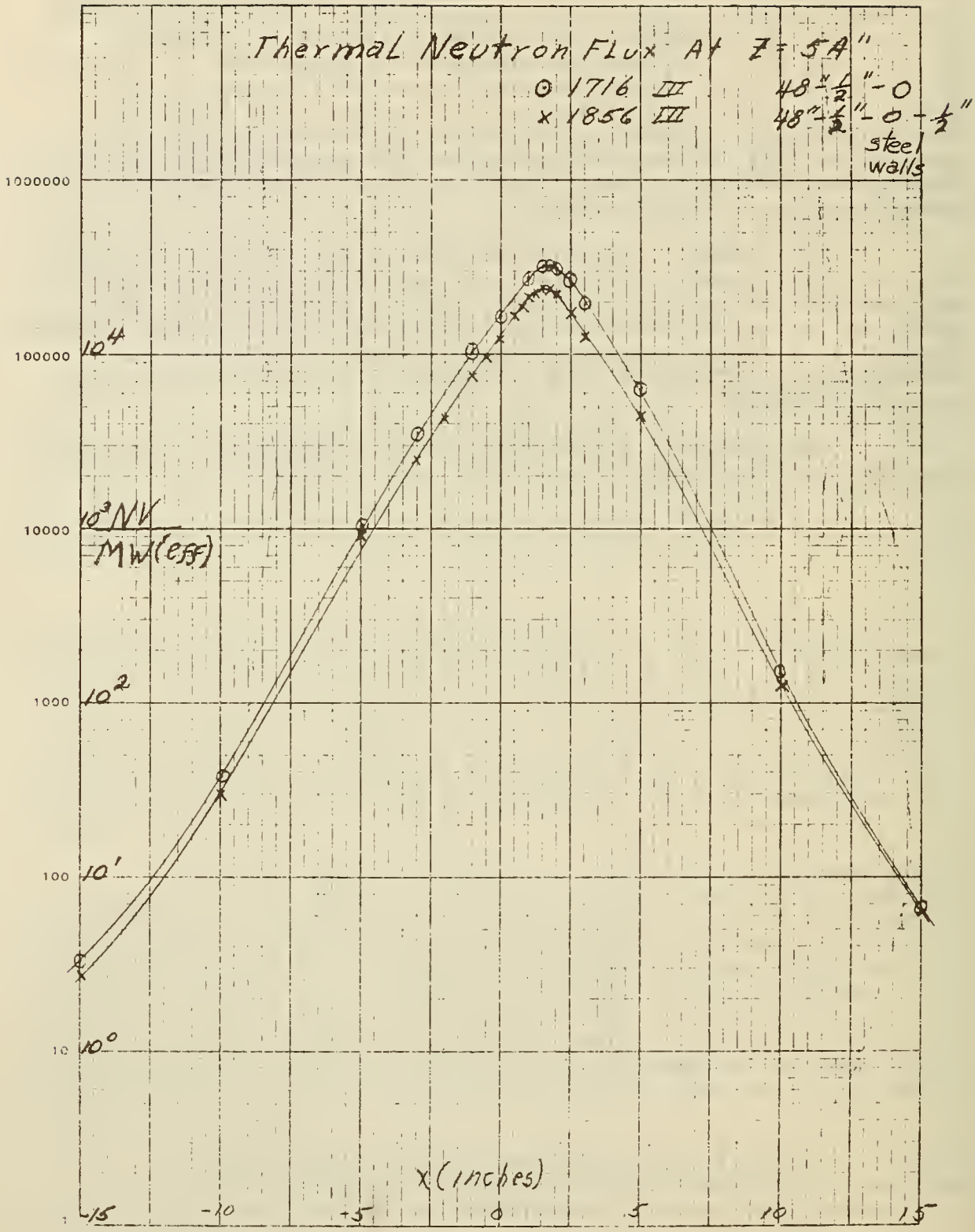

Thermal Neutron Flux At Z = 5A"
⊙ 1716 III 48"-½"-0
× 1856 III 48"-½"-0-½"
steel walls
1000000
100000
10000
1000
100
10
1
10^4
10^3 NV / MW(eff)
10^2
10^1
10^0
x (inches)
-15
-10
-5
0
5
10
15

Figure 2

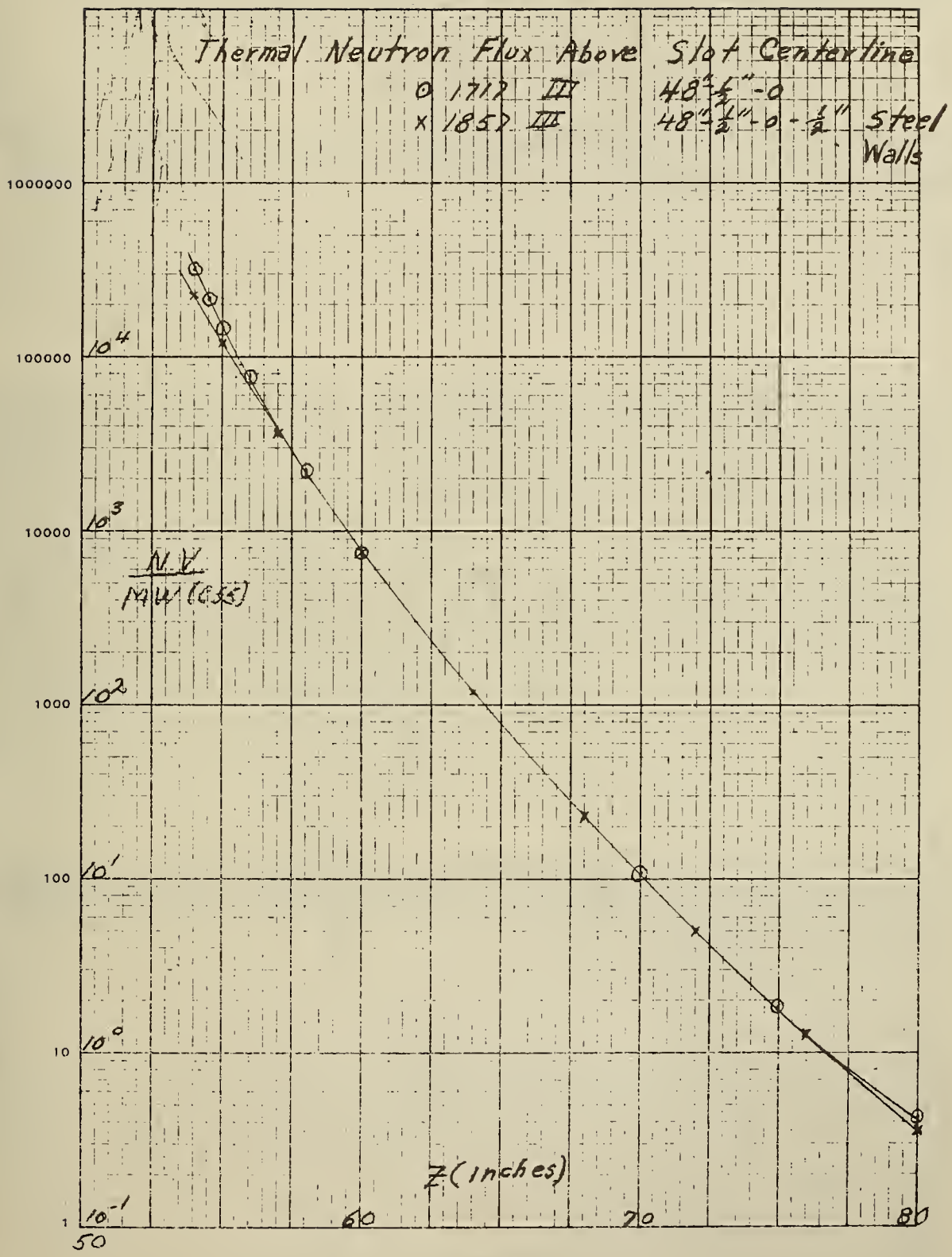

Thermal Neutron Flux Above Slot Centerline
⊙ 1712 III 48"-½"-0
× 1852 III 48"-½"-0-½" Steel Walls
1000000
100000
10000
1000
100
10
1
10^4
10^3
10^2
10^1
10^0
10^{-1}
NV / MW (CSS)
Z (inches)
50
60
70
80

Figure 3

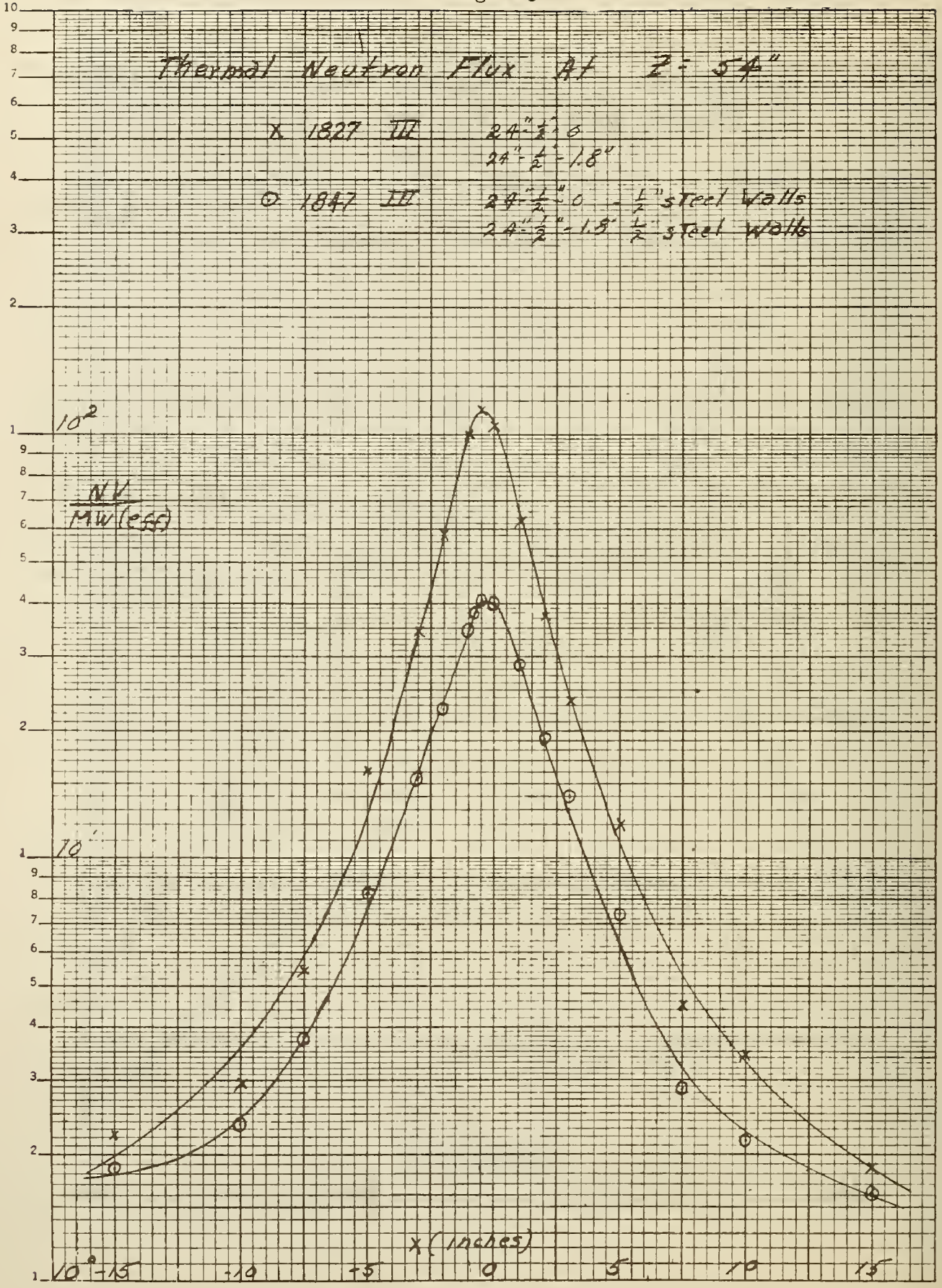

Thermal Neutron Flux At Z = 54"
X 1827 III 24" - 1/2" - 0
24" - 1/2" - 1.8"
⊙ 1847 III 24" - 1/2" - 0 - 1/2" steel walls
24" - 1/2" - 1.8" 1/2" steel walls
10^2
NV / MW(eff)
10^1
10^0
X (inches)
-15
-10
-5
0
5
10
15

Figure 4

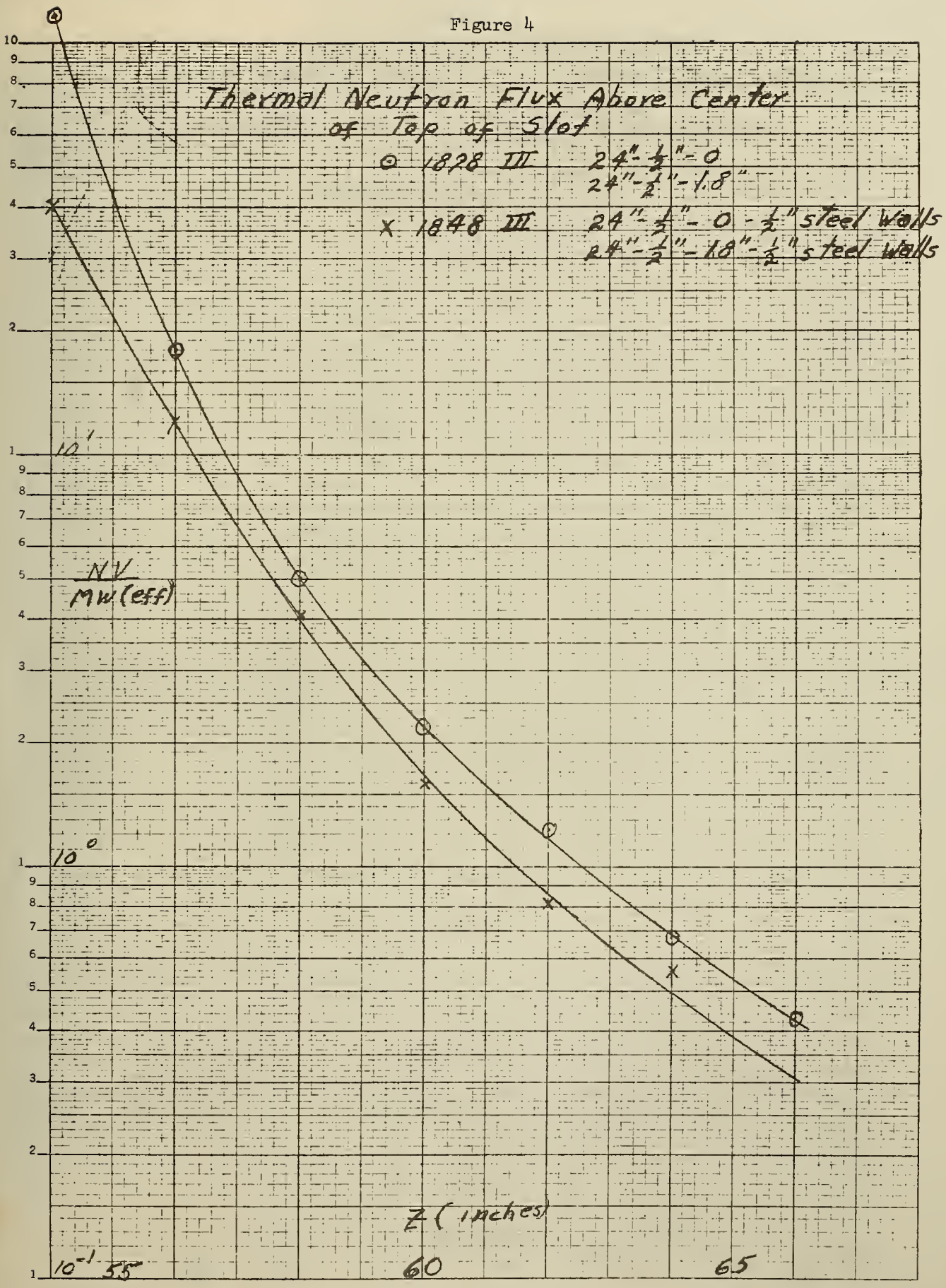
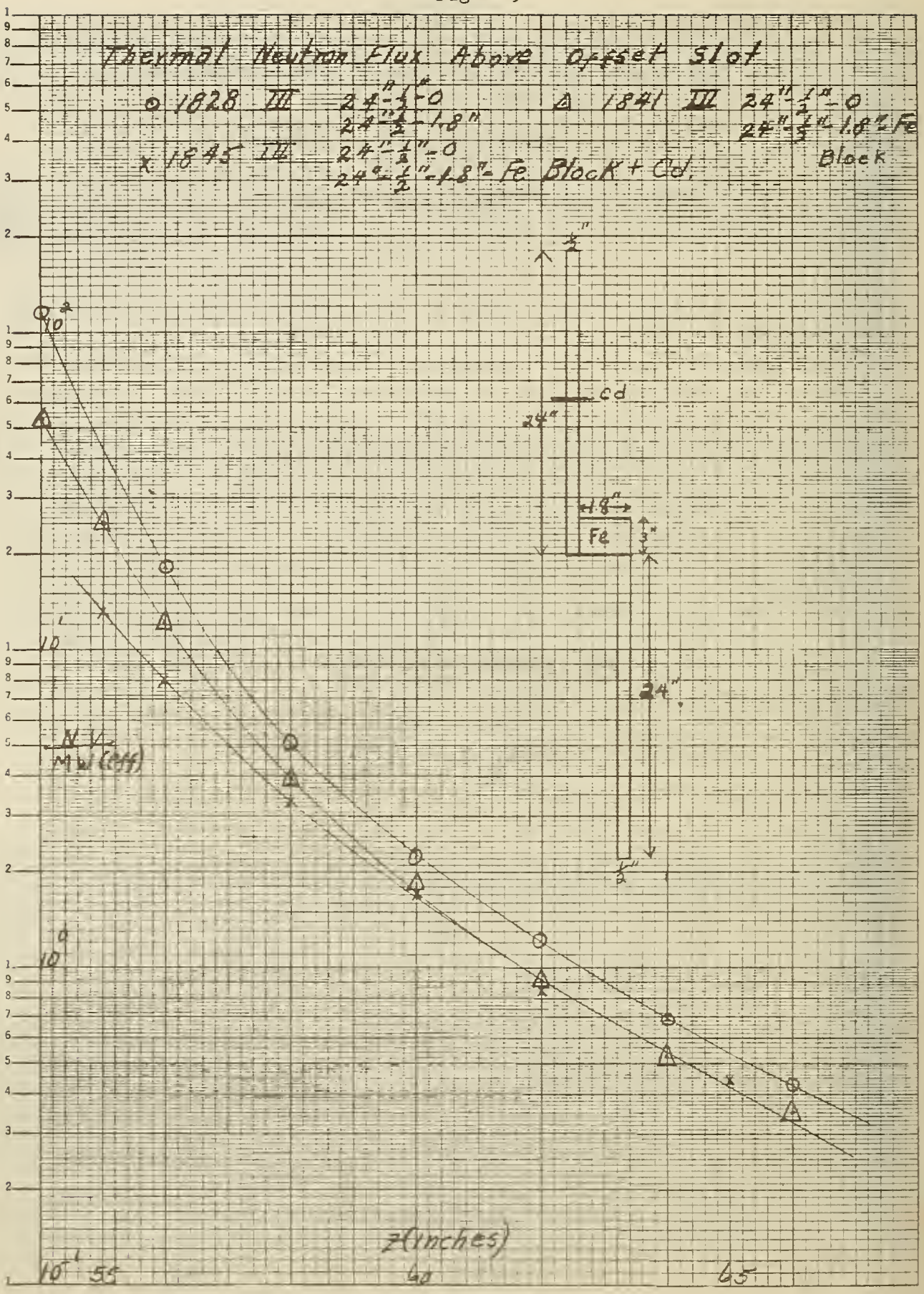

Thermal Neutron Flux Above Center of Top of Slot
⊙ 1828 III 24"-½"-0
24"-½"-18"
x 1848 III 24"-½"-0-½" steel walls
24"-½"-18"-½" steel walls
NV / Mw(eff)
Z (inches)
10^1
10^0
10^-1
55
60
65

Figure 5



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